US Army Corps
of Engineers
Hydrologic Engineering Center

GENERALIZED COMPUTER PROGRAM

HYDPAR

Hydrologic Parameters

User's Manual

July 1985

CPD-34

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Hydrologic Engineering Center
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CPD-34

HYDROLOGIC PARAMETERS

(HYDPAR)

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HYDROLOGIC PARAMETERS
(HYDPAR)

INTRODUCTION

The HYDPAR (hydrologic parameters) computer program is part of a family of computer programs that make up the Hydrologic Engineering Center's Spatial Data Management and Comprehensive Analysis System (HECSAM). This system represents an ongoing effort to provide a systematic and comprehensive technique for managing and analyzing spatial data for use in water resources management investigations.

The HYDPAR program is designed to access and process data stored in a grid cell data bank. The particular methods used in storing and accessing spatial data which are utilized by this computer program are described in a guide manual available from the Hydrologic Engineering Center (U.S. Army Corps of Engineers, 1978).

An overview of the program's requirements and capabilities are presented herein. In addition, the input necessary for program execution and related output are described in detail for the benefit of the user. Sample output has also been included to demonstrate the capabilities of the system and as a data set for testing the computer program.

The HYDPAR program is maintained and distributed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, 609 Second Street, Davis, California, 95616. This agency should be contacted for any questions regarding its use or availability.

General Description

Subbasin or watershed hydrologic parameters that might be used as input to rainfall-runoff models or other analytical techniques can be determined by using the HYDPAR program. At present the parameters that can be generated are (1) those needed for the U.S. Soil Conservation Service (SCS) Curve Number (CN) technique and (2) those needed for watershed modeling using

subbasin imperviousness and characteristics of the Snyder unit hydrograph procedure. The hydrologic parameters that are computed with the aid of the HYDPAR program and a grid cell data bank may be manually input into the rainfall-runoff computer program HEC-1 (U.S. Army Corps of Engineers, 1973) or the transfer process may be automated between HYDPAR and HEC-1 by using the HEC data storage system (DSS) or some other interface.

Input Limitations. The limitation on input data to the HYDPAR program is defined through the use of a dynamic array. The variable names of the input categories are given below, as well as the expression needed to compute the maximum index value of that array.

Input	Variable
Number of Subbasins	NSUB
Number of Land Use Categories	NLUSE
Number of Slope Categories (SCS type)	NSLP
Number of Data Variables in the Grid Cell Data Bank	NVAR

$$y = (16 * NSUB) + (10 * NLUSE) + 5(NSUB * NLUSE) + NVAR + NSLP \qquad (1)$$

The value of y varies depending on the type of computer being used. On Harris equipment y cannot exceed 131,000. On CDC Cybernet, y cannot exceed 80,000.

Hardware and Software Requirements. The HYDPAR program was developed in FORTRAN IV using a CDC 7600 computer. The source has been converted to FORTRAN 77 and presently is supported on Harris minicomputers and CDC mainframes. The program is also available for use on an IBM-PC or equivalent microcomputer. In general, it is compatible with other major computer systems. The HEC data storage system (DSS) provides the linkage between HYDPAR and HEC-1 and is presently only available to the U.S. Army Corps of Engineers. Work is underway to make the DSS compatible with most major computer systems.

Program Language:	FORTRAN 77
Memory Requirement: (on CDC)	377,000 words (octal)

Special Library Functions:		**DSS software**
Printer Positions:		**132**
File Assignments:	**Tape1:**	**Grid cell data bank**
	Tape5:	**Standard record input**
	Tape6:	**Standard line printer**
	Tape71:	**DSS output (DSS version only)**

Specific Capabilities. The HYDPAR program computes and formats for subsequent use hydrologic parameters that permit determination of precipitation loss-rate functions and surface runoff response.

The program has the capability to compute SCS Curve Numbers and unit hydrograph parameters (basin lag) based on the SCS dimensionless unit hydrograph procedure. The program also has the option to compute the percent of impervious surface within a watershed and calculate unit hydrograph parameters utilizing the Snyder approach. Example applications are contained in "Phase I Oconee Basin Pilot Study - Trail Creek Test" (U.S. Army Corps of Engineers, 1975) and the Training Document "Application of Spatial Data Techniques to HEC-1 Rainfall- Runoff Studies (U.S. Army Corps of Engineers, 1983).

The functions defining the relationships between the geographic data drawn from the grid cell data bank (land use, subbasin boundaries, hydrologic soil group, surface slope, etc.) and the selected procedure are defined externally and input to HYDPAR. The HYDPAR program performs the appropriate file manipulations, computations and bookkeeping, prints the results, and then if the user desires, writes a file for further automated processing. The results (Tape71) may be saved utilizing DSS software if the results are to be used as input to the HEC-1 program at a later time. (System control records are used to save Tape71).

The HYDPAR program computes drainage areas for subbasins by one of two methods: (1) by multiplying the size of the grid cell area by the sum of the cells falling within each subbasin, or (2) by taking a proportion of the total watershed area based on the number of cells within each subbasin.

A significant amount of bookkeeping relating to land use, computational procedures, etc. is performed and displayed as output.

COMPUTATIONAL PROCEDURES

<u>Soil Conservation Service (SCS) Methods</u>. The U.S. Soil Conservation Service (SCS) developed a technique for determining direct runoff from rainfall based on land use, antecedent moisture conditions and soil type. The technique (Curve Number technique) is especially attractive to many hydrologic planning evaluations since it provides a systematic and consistent method of evaluating the effect of alternative land use patterns on surface runoff within a watershed (U.S. Soil Conservation Service, 1972).

The SCS method uses a relationship in which accumulated runoff is a function of accumulated rainfall and the physiographic characteristics, land use, antecedent moisture and soil type. Curve numbers have been developed to represent various combined states of these particular physiographic parameters.

In the HYDPAR program, only land use and soil type are utilized in determining a curve number (CN). The process involves accessing the grid cell data bank and determining the land use and soil type for each grid cell. Then, based on an input relationship between CN and these two particular parameters, a value (of CN) is assigned to each cell. Based on the number of cells in each subbasin and their respective CNs, an average value of CN is then computed for each subbasin in the study area.

Since the curve number technique is used to determine the amount of surface runoff generated by a given storm (or precipitation) event, an additional technique is required to develop the shape of the discharge hydrograph (discharge versus time) at a subbasin outlet. In order to do this, the SCS has developed a simplified dimensionless unit hydrograph approach to transform excess rainfall (direct runoff) to discharge as a function of time (U.S. Soil Conservation Service, 1972). The shape of the SCS unit hydrograph is based on a single parameter, basin time lag (time response of runoff to rainfall), which in normal practice is estimated from one of several empirical equations, from travel time studies or from observed flood hydrograph reconstitutions. The HYDPAR program computes basin lag from an empirical equation recommended by the SCS.

This particular lag equation was adopted because its structure permits easy modification of the unit hydrograph based on changes in land use. The lag equation used is

$$\text{Lag (hours)} = \frac{(L)^{.8} \; * \; (S + 1)^{.7}}{(1900) \; * \; (y)^{.5}} \qquad (2)$$

where L = hydraulic length of subbasin (the watercourse length from subbasin outlet to the upstream boundary which yields the longest time of travel) in feet,

y = average subbasin land slope in percent (determined from the HYDPAR program based on slope data for each grid cell)

S = (1000/CN) - 10, and

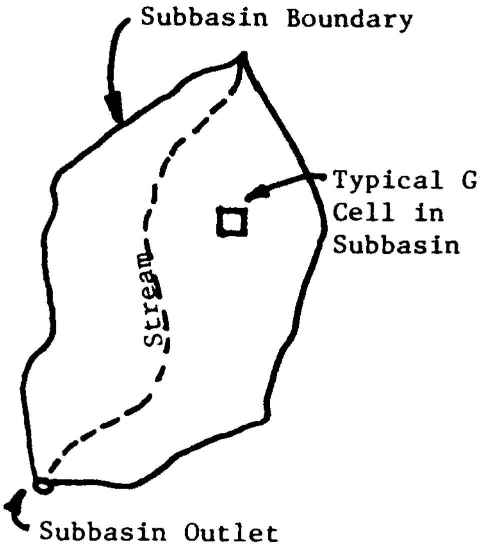
CN = arithmetic average curve number

<u>NOTE: L is input by the user in miles and converted to feet within the program for calculation purposes</u>.

The subbasin or watershed CN used in the lag computation is the same value previously computed with the aid of the HYDPAR program; and the land slope, y, is computed as an arithmetic average of the land slope of each cell within the subbasin under investigation.

Fig. 1, conceptually displays the data that must be available in the grid cell data bank and the computational procedures used to determine the hydrologic parameters, curve number and subbasin lag time.

DATA REQUIRED



5	Grid representation of land use (exhaustive for study area).
3	Grid representation of hydrologic soil group.
12	Grid representation of subbasin.
7	Grid representation of land surface slope.
DIRECT INPUT	
_____ -- -- -- --	Tabulation of land use-soil type curve number. (Not part of grid data bank).
1.30 miles	Subbasin hydraulic length. (Not part of grid data bank)

PROCEDURE

COMPUTATION OF SUBBASIN AVERAGE CURVE NUMBER (CN)

a. Determine cell land use from grid data bank.
b. Determine cell hydrologic soil group from grid data bank.
c. Determine cell curve number (CN) from input relationship.
d. Determine cell subbasin assignment.
e. Aggregate CNs for all cells within subbasin and compute average value.

COMPUTATION OF SUBBASIN LAG TIME (EQUATION 2)

a. Determine cell land surface slope from grid data bank.
b. Determine cell subbasin assignment from grid data bank.
c. Aggregate land surface slope for all cells within subbasin and compute mean value.
d. Retrieve average CN computed above.
e. Compute subbasin lag.

Lag = f (curve number, hydraulic length, mean slope)

Fig. 1

HYDROLOGIC PARAMETER COMPUTATION

Composite Imperviousness and Snyder Methods. A common method utilized in urban hydrology studies is to determine a precipitation loss rate for an observed flood event (discharge hydrograph) or events associated with a particular estimated value of impervious surface. The type of loss rate function is not important but is frequently the simple initial plus uniform loss formulation commonly used by personnel of the Army Corps of Engineers (U.S. Army, Corps of Engineers, 1973). Estimation of the effect of changing land use on runoff is performed by recomputing the proportion of imperviousness for an alternative land use plan and adjusting the loss rate accordingly. The HYDPAR program computationally implements this basic concept by assigning percent values of imperviousness to each grid cell based on input land use and then computes an average percent imperviousness for the subbasins under investigation. Any change in land use contemplated for a particular grid cell would necessitate recomputation of the subbasin (containing that grid cell) imperviousness.

Several investigators have attempted to capture the rainfall-runoff response to land use change by performing regression studies of unit hydrograph parameters (Gundlach, 1976). Typically, regression expressions were derived in which a parameter, such as basin lag, was expressed as a function of subbasin area, imperviousness, and perhaps other physiographic characteristics. The HYDPAR program computes a Snyder's lag (U.S. Army Corps of Engineers, 1973) based on a generalized equation of this type in which

$$t_p = C(X^{C1}) \quad (10^{C2I}) \tag{3}$$

where t_p = Snyder's lag in hours

C = regression constant

$X = \frac{L * LCA}{S}$

L = characteristic stream length in miles

LCA = length from subbasin outlet along stream channel to a point opposite the centroid of the subbasin area in miles

S = characteristic stream slope in feet per mile

$C1$ = regression coefficient

$C2$ = regression coefficient

I = imperviousness in percent

The applicability of expression 3 would have to be determined from an analysis of regional data. If the expression is reasonably predictive then the values of the coefficients could be determined for input to the HYDPAR program.

Fig. 1 is a conceptually accurate display of the computational steps needed for this method of calculating hydrologic parameters (needed in the determination of direct runoff) as well. However, not all the data in the grid cell data bank necessary for the SCS computations is needed when utilizing equation 3 (as will be shown later in this section).

INPUT PREPARATION

<u>General Description</u>. The following material describes the data (for the HYDPAR computer program) which are entered on each input record and the type of records needed for the desired analysis to be performed.

The program is flexible to a degree in the data that can be input for analysis and in the detail of the output desired. Not all of the input records are required.

<u>Program Data Hierarchy</u>. The general hierarchy of the major data types used in this program is displayed in Table 1.

Records	
TITLE RECORDS JOB RECORDS - Type of Analysis - Size and Format of Grid Cell Data File - Data Variable Location	Apply to every job
SUBBASIN DATA RECORDS - Equation Constants - Table of CN-values - Table of Land Use Category Versus Percent Imperviousness	Apply to all subbasins
- Characteristic Stream Length - Characteristic Stream Slope - LCA	Apply to a specific subbasin

TABLE 1
PROGRAM DATA HIERARCHY

DATA RECORD DESCRIPTION

Title Records, T1, T2, T3. The title records are required. They provide output display information that can readily identify the project and the particular job. The content of the title records is optional, but it is suggested that they include a record of the project name, data notes, selected program options, and any unique features of the job. The information on the title records is printed at the top of each page of the computer printout.

First Job Record, J1. This required record specifies the type of hydrologic parameters calculated, the printout option, the dimensions of the data base, the area size of the grid cell, and whether or not the grid cell data bank is formatted.

Second Job Record, J2. This required record describes the number of data variables in the data bank and the sequence number (location) of the variables required for analysis.

DSS Pathname Data Record, ZW. This optional record describes the pathname used by the DSS when storing hydrologic loss rate and unit hydrograph parameters for later use by HEC-1.

Format Record, FT. This optional record describes the grid cell data bank format, if the data bank is formatted.

Subbasin Data Records, EQ, SL, LU, SB. These particular records are, in general, utilized in the different computational methods, either the SCS or composite imperviousness and Snyder procedures.

- Equation Constant Record, EQ. An optional record which specifies the regression constant and coefficients required by equation 3 (in the computation of Snyder's basin lag).

- Slope Record(s), SL. An optional record(s) which defines the slope values for the SCS slope categories recorded in numerical sequence in the grid cell data bank. This permits the computation of an arithmetic average

slope for each subbasin. (This record is not required if an estimated subbasin slope value is input directly.)

- Land Use Records, LU. Land use records are required and describe the range of Curve Numbers associated with each land use category in the grid cell data bank for the various soil types included. (If the subbasin imperviousness is computed, then the land use records would supply the percent imperviousness associated with each land use category).

Program Termination Record, END. This required record terminates program execution.

OUTPUT DISPLAY

The description of the output is accompanied by sample printouts, Exhibits 1 and 2. In order to simplify the output, not all specific subbasin data is included for every subbasin. The numbers in parentheses in the text refer to a specific line (or series of lines) that is numbered on the sample output.

The line printer output begins with the name of the program (see Exhibit 1), the program version date, and the origin of the program (1). The run date and time are printed as an aid in identifying the output (2).

Input Listing. A display of the input data is provided at user request (3).

Title. The information on the title records is printed at the top of each output page (4).

Job Records. The data on the job records is first displayed in a record image format (5) prior to a more descriptive definition of the variables. The variable and input values follow with a brief description of each variable (6).

DSS File Identification. If the ZW record is used to identify the pathname when storing data for later use, then an image of that record is printed and a definition of each of the record parameters is given (7)

Format Data. If the data bank is formatted, a format record is input and an image of that record is displayed (8).

Regression Constants. If the percent imperviousness technique was used in this example, the equation values would be printed as a record image, and the regression constant and coefficient values then displayed with the equation variables they represent. (No regression constants are displayed in the SCS Curve Number Technique).

Equation. The equation that is used in the requested procedure is displayed along with definitions of the equation variables. For this sample calculation, the SCS Lag equation is utilized (9).

Slope. The slope record, if required, is printed first as an image of the input record (10); then the slope class and average percent values are tabulated (11).

The remaining portion of the output depends on the type of hydrologic parameter calculation selected by the user. A description of the output for the SCS Curve Number method is given below and included in Exhibit 1, followed by a description of Snyder's Lag method, Exhibit 2.

Curve Number Table. A record image of each LU record is shown in Exhibit 1 (12). The Curve Number table identifies the Curve Numbers assigned to each hydrologic soil group within a given land use category (13).

Subbasin Parameter Records. Record images of the SB record(s) input are also included (14). This display provides an opportunity to check the input values of the subbasin data.

Subbasin Summary Table. For each subbasin under analysis, the stream length (miles), length to the centroid of the area (miles), stream slope (feet per mile), and the HYDPAR subbasin designation are given (15). (The centroid length is not needed for this computational technique and the HEC-1 stations are required only when the results are saved for automated interface with the HEC-1 computer program).

Specific Subbasin Data. Computational results are printed sequentially for each subbasin. Each subbasin is identified (16) and the land use categories that exist within its boundary are listed. For each identified land use, data is printed for four headings: Average Curve Number, surface slope (percent), area in acres, and percent of the subbasin that is occupied by a specific land use (17). For each subbasin, the computed average values of Curve Number and surface slope are given (18). The percentage of the subbasin area associated with a given land use is used to weight the curve number and surface slope and the weighted values are then used to produce the subbasin averages. A tabulation of pertinent data and computed hydrologic parameters is also printed (19). (It should be noted that in this instance stream length and slope were input directly).

Summary of Subbasin Data. The summary output is a condensed version of subbasin data (20). Each subbasin is identified and for each subbasin, computed values of drainage area, percent of watershed (represented by the identified subbasin), average curve number, subbasin lag, and subbasin slope are given. (The stream length and slope values were provided initially with the input data).

DSS File System Information. The data written to a DSS file for use by HEC-1 utilizing HECDSS software is displayed (21).

SNYDER'S LAG TECHNIQUE

The option in the HYDPAR program which permits the user to compute Snyder's basin lag according to equation 3 and the percentage of impervious surface within a subbasin is detailed below. Several pages of output relating to this computational procedure are included in Exhibit 2. As in the previous example, the numbers in parentheses in the text refer to particular parts of the sample output.

Equation. The equation that is utilized in this procedure is given (22) along with definitions of the different variables.

Percent Impervious Summary. A record image of each LU record is provided (23). A table of user-provided values is displayed showing the percent imperviousness for each land use category (24).

Subbasin Parameter Records. Record images of the SB record input are included in the output. This display provides an opportunity to verify the input values of the subbasin data (25).

Subbasin Summary Table. For each subbasin under analysis, the stream length (miles), length to the centroid of the area (miles), stream slope (feet per mile), and HEC-1 station values are given (26). HEC-1 stations are required only when the results of the job are saved for automated interfacing with the HEC-1 program through the DSS.

Specific Subbasin Data. Specific subbasin data is tabulated (27). For each land use category in the subbasin, values are output for percent imperviousness, surface slope (not required for Snyder's technique), area, and the proportion of the subbasin that is occupied by a particular land use category (28). The percentage of the subbasin area associated with a given land use is used to weight the percent imperviousness to derive the subbasin average (29).

Included in the data output for each subbasin is the computed basin lag (TP), along with drainage area, stream length, length to centroid (LCA), stream and subbasin slope, average imperviousness, and the number of grid cells (30).

Summary of Subbasin Data. One of the final pages of output is a summary table of the subbasin values (31). The subbasins are identified, and computed values are supplied for the following categories; drainage area, percent of watershed that is represented by the identified subbasin, percent imperviousness, TP (lag), and subbasin slope. The remaining headings reflect input values.

SAMPLE PROBLEMS

Sample problems illustrating the two types of calculations currently available utilizing the HYDPAR computer program are included in Exhibits 3 and 4. The sample input and output will provide the user with an overall description of the data necessary for program execution. The sample problems will also provide a valid data set to verify program operations on other computer systems. The necessary data input categories and codes used from

and codes used from the Trail Creek data bank are incorporated in each of the problems. (It should be noted that the output display is incomplete. Specific subbasin data is given for only one of the twenty-one subbasins in the Trail Creek Watershed).

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U.S. Army Corps of Engineers, October 1983, Application of Spatial Data Management Techniques to HEC-1 Rainfall-runoff Studies

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EXHIBIT 1

SCS CURVE NUMBER TECHNIQUE

HYDROLOGIC PARAMETERS

(HYDPAR)

```
*************************************************     ****************************************
* HYDROLOGIC PARAMETERS COMPUTER PROGRAM        *     * U.S. ARMY CORPS OF ENGINEERS         *
* USERS MANUAL JULY  1985                       *     * THE HYDROLOGIC ENGINEERING CENTER    *
* UPDATED JULY  1985                            *     * 609 SECOND STREET                    *
*                                               *     * DAVIS, CALIFORNIA 95616-4687         *
* RUN DATE 24 APR 85  TIME  14:49:19            *     * (916) 440-2105 (FTS) 448-2105        *
*************************************************     ****************************************
```

1

2

```
H     H Y     Y DDDDDD  PPPPPP     A     RRRRRR
H     H  Y   Y  D     D P     P   A A    R     R
H     H   Y Y   D     D P     P  A   A   R     R
HHHHHHH    Y    D     D PPPPPP  AAAAAAA  RRRRRR
H     H    Y    D     D P       A     A  R   R
H     H    Y    D     D P       A     A  R    R
H     H    Y    DDDDDD  P       A     A  R     R
```

Exhibit 1

SCS CURVE NUMBER TECHNIQUE   EXHIBIT 1
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

LIST OF INPUT CARDS FOR THIS RUN 3

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890

T1                            SCS CURVE NUMBER TECHNIQUE          EXHIBIT 1
T2                           HYDPAR HYDROLOGIC PARAMETERS
T3                                      APRIL 1985
J1     0       1       1      92     129    1.53
J2    18      21       4      10      10       7       8       7
ZW  TRAIL CREEK  EXISTING LAND USE
FT(12F4.0,2F8.2,2F4.0,2F2.0)
SL   1.0     4.0     8.0    13.0    20.0    35.0    50.0
LU     1      36      60      73      79      3NATURAL VEGETATION
LU     2      39      61      74      80      8DEVELOPED OPEN SPACE
LU     3      47      66      77      81     20LOW DENSITY RESIDENTIAL
LU     4      61      75      83      87     28MEDIUM DENSITY RESIDENTIAL
LU     5      80      85      90      95     40HIGH DENSITY RESIDENTIAL
LU     6      67      78      85      89      3AGRICULTURE
LU     7      83      88      92      96     68INDUSTRIAL
LU     8      95      96      97      98     85COMME°CIAL
LU     9      49      69      79      84      3PASTURE
LU    10     100     100     100     100    100WATER BODIES
SB     1     .95     .48     113   TC-01
SB     2    1.36     .68      69   TC-02
SB     3    1.25     .62      90   TC-03
SB     4    1.14     .57     118   TC-04
SB     5     .76     .38     123   TC-05
SB     6     .70     .35     132   TC-06
SB     7    1.40     .70     105   TC-07
SB     8    1.74     .87      61   TC-08
SB     9    1.33     .66     116   TC-09
SB    10     .85     .42      94   TC-10
SB    11    1.00     .50      80   TC-11
SB    12    1.08     .54     105   TC-12
SB    13    1.46     .73      78   TC-13
SB    14    1.76     .88      80   TC-14
SB    15    1.14     .57     106   TC-15
SB    16    1.80     .90      78   TC-16
SB    17    1.59     .80     101   TC-17
SB    18     .89     .44     149   TC-18
SB    19    1.14     .57     118   TC-19
SB    20     .87     .44     138   TC-20
SB    21    1.21     .60     143   TC-21
END
```

4

SCS CURVE NUMBER TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 1

```
J1 CARD
-------
CC 1234567890123456789012345678901234567890123456789012345678901234567890123456789O
   J1     0       1       1      92      129     1.53
```

5

6

```
J1 JOB PARAMETERS
-----------------

IANL   =      0, CURVE NUMBER AND SCS LAG WILL BE COMPUTED FOR EACH SUBBASIN

ILUPRT =      1, LIST INPUT CARDS + NORMAL PRINTOUT

IFMT   =      1, GRID CELL DATA BANK IS FORMATTED

NROW   =    '92, TOTAL NUMBER OF ROWS IN DATA BANK

NCOL   =    129, TOTAL NUMBER OF COLUMNS IN DATA BANK

SIZE   =   1.53, THE SIZE OF THE GRID CELL IS IN ACRES
```

SCS CURVE NUMBER TECHNIQUE EXHIBIT 1
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

J2 CARD

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   J2    18      21       4      10      10       7       8       7
```

J2 JOB PARAMETERS

```
NVAR  =   18, THE NUMBER OF DATA VARIABLES PER GRID CELL RECORD

NSUB  =   21, THE NUMBER OF SUBBASINS ANALYZED IN THIS RUN

IBS   =    4, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE SUBBASIN CODE

NLUSE =   10, THE NUMBER OF LAND USE CATEGORIES IN THE GRID CELL DATA BANK

ILD   =   10, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE LAND USE PATTERN TO BE ANALYZED

NSLP  =    7, THE NUMBER OF SLOPE CLASSES FOR CURVE NUMBER ANALYSIS

ISLP  =    8, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE SCS LAND SURFACE SLOPE CODE

IHYO  =    7, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE HYDROLOGIC SOIL GROUP CODE
```

```
                    HECDSS WRITE CARD
                    -----------------                                       (7)
CC 1234567890123456789012345678901234567890123456789012345678901234567890
   ZW  TRAIL CREEK  EXISTING LAND USE

                    FILE SYSTEM INFORMATION - A FILE WILL BE CREATED TO PASS HYDROLOGIC
                    -----------------------   PARAMETERS TO HEC-1 USING THE HEC DATA STORAGE SYSTEM (HECDSS).

                    PROJ   =      TRAIL CREEK

                    ALT    =     EXISTING LAND USE

                    IYR    =

               -----DSS---ZOPEN     NEW FILE OPENED   71  0000R10B*U1     A


                    FORMAT CARD
                    -----------                                             (8)
CC 1234567890123456789012345678901234567890123456789012345678901234567890
   FT(12F4.0,2F8.2,2F4.0,2F2.0)
```

SCS CURVE NUMBER TECHNIQUE EXHIBIT 1
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

LAG EQUATION 9

****

$$\text{LAG (HOURS)} = \frac{(L)^{0.8}\,(S+1)^{0.7}}{(1900)(Y)^{0.5}}$$

WHERE --

L = THE HYDRAULIC LENGTH OF WATERSHED IN FEET

Y = AVERAGE SUBBASIN LAND SLOPE IN PER CENT

S = (1000/CN)-10
WHERE CN IS THE CURVE NUMBER

THE SUBBASIN CURVE NUMBER IS A WEIGHTED AVERAGE FOR THE LAND USE WITHIN THE HYDROLOGIC SOIL GROUPS. SUBBASIN SLOPE IS A SIMPLE AVERAGE AND SUBBASIN STREAM SLOPE AND LENGTH ARE DETERMINED EXTERNALLY AND DIRECTLY INPUT.

SCS CURVE NUMBER TECHNIQUE EXHIBIT 1
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

SLOPE CLASS AVERAGES

```
CC 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
 SL    1.      4.      8.     13.     20.     35.     50.      0.      0.      0.
```

10

11

SLOPE CLASS	AVERAGE PERCENT
1	1.000
2	4.000
3	8.000
4	13.000
5	20.000
6	35.000
7	50.000

SCS CURVE NUMBER TECHNIQUE EXHIBIT 1
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

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LAND USE CATEGORIES

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   LU    1    36.    60.    73.    79.      3.NATURAL VEGETATION
   LU    2    39.    61.    74.    80.      8.DEVELOPED OPEN SPACE
   LU    3    47.    66.    77.    81.     20.LOW DENSITY RESIDENTIAL
   LU    4    61.    75.    83.    87.     28.MEDIUM DENSITY RESIDENTIAL
   LU    5    80.    85.    90.    95.     40.HIGH DENSITY RESIDENTIAL
   LU    6    67.    78.    85.    89.      3.AGRICULTURE
   LU    7    83.    88.    92.    96.     68.INDUSTRIAL
   LU    8    95.    96.    97.    98.     85.COMMERCIAL
   LU    9    49.    69.    79.    84.      3.PASTURE
   LU   10   100.   100.   100.   100.    100.WATER BODIES
```

CURVE NUMBER SUMMARY WITH
ASSOCIATED LAND USE CATEGORIES

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LAND USE CATEGORY	TITLE	HYDROLOGIC SOIL GROUP			
		A	B	C	D
1	NATURAL VEGETATION	36.	60.	73.	79.
2	DEVELOPED OPEN SPACE	39.	61.	74.	80.
3	LOW DENSITY RESIDENTIAL	47.	66.	77.	81.
4	MEDIUM DENSITY RESIDENTIAL	61.	75.	83.	87.
5	HIGH DENSITY RESIDENTIAL	80.	85.	90.	95.
6	AGRICULTURE	67.	78.	85.	89.
7	INDUSTRIAL	83.	88.	92.	96.
8	COMMERCIAL	95.	96.	97.	98.
9	PASTURE	49.	69.	79.	84.
10	WATER BODIES	100.	100.	100.	100.

SCS CURVE NUMBER TECHNIQUE EXHIBIT 1
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

(14)

SUBBASIN PARAMETER CARDS

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   SB    1.    0.95    0.48   113.0   TC-01    0.00
   SB    2.    1.36    0.68    69.0   TC-02    0.00
   SB    3.    1.25    0.62    90.0   TC-03    0.00
   SB    4.    1.14    0.57   118.0   TC-04    0.00
   SB    5.    0.76    0.38   123.0   TC-05    0.00
   SB    6.    0.70    0.35   132.0   TC-06    0.00
   SB    7.    1.40    0.70   105.0   TC-07    0.00
   SB    8.    1.74    0.87    61.0   TC-08    0.00
   SB    9.    1.33    0.66   116.0   TC-09    0.00
   SB   10.    0.85    0.42    94.0   TC-10    0.00
   SB   11.    1.00    0.50    80.0   TC-11    0.00
   SB   12.    1.08    0.54   105.0   TC-12    0.00
   SB   13.    1.46    0.73    78.0   TC-13    0.00
   SB   14.    1.76    0.88    80.0   TC-14    0.00
   SB   15.    1.14    0.57   106.0   TC-15    0.00
   SB   16.    1.80    0.90    78.0   TC-16    0.00
   SB   17.    1.59    0.80   101.0   TC-17    0.00
   SB   18.    0.89    0.44   149.0   TC-18    0.00
   SB   19.    1.14    0.57   118.0   TC-19    0.00
   SB   20.    0.87    0.44   138.0   TC-20    0.00
   SB   21.    1.21    0.60   143.0   TC-21    0.00
```

SUBBASIN SUMMARY TABLE

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HYDPAR SUBBASIN	STREAM LENGTH (MILES)	LENGTH TO CENTROID (MILES)	STREAM SLOPE (FT./MI.)	HEC-1 STATION	SNYDER"S CP
1.	0.95	0.48	113.0	TC-01	0.00
2.	1.36	0.68	69.0	TC-02	0.00
3.	1.25	0.62	90.0	TC-03	0.00
4.	1.14	0.57	118.0	TC-04	0.00
5.	0.76	0.38	123.0	TC-05	0.00
6.	0.70	0.35	132.0	TC-06	0.00
7.	1.40	0.70	105.0	TC-07	0.00
8.	1.74	0.87	61.0	TC-08	0.00
9.	1.33	0.66	116.0	TC-09	0.00
10.	0.85	0.42	94.0	TC-10	0.00
11.	1.00	0.30	80.0	TC-11	0.00
12.	1.08	0.54	105.0	TC-12	0.00
13.	1.46	0.73	78.0	TC-13	0.00
14.	1.76	0.88	80.0	TC-14	0.00
15.	1.14	0.57	106.0	TC-15	0.00
16.	1.80	0.90	78.0	TC-16	0.00
17.	1.59	0.80	101.0	TC-17	0.00
18.	0.89	0.44	149.0	TC-18	0.00
19.	1.14	0.57	118.0	TC-19	0.00
20.	0.87	0.44	138.0	TC-20	0.00
21.	1.21	0.60	143.0	TC-21	0.00

SCS CURVE NUMBER TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 1

SUBBASIN 1. 16

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LAND USE CATEGORY	LAND USE	AVE CURVE NO.	SURFACE SLOPE (PERCENT)	AREA IN ACRES	PERCENT OF SUBBASIN 17
1	NATURAL VEGETATION	61.0	7.25	223.38	48.99
3	LOW DENSITY RESIDENTIAL	67.0	4.82	68.85	15.10
6	AGRICULTURE	78.0	6.49	157.59	34.56
10	WATER BODIES	100.0	1.00	6.12	1.34
	SUBBASIN AVERAGE	68.3	6.54	455.94	

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SUBBASIN 1. DATA		
DRAINAGE AREA (ACRES)	=	455.94
DRAINAGE AREA (SQ. MI.)	=	0.71
STREAM LENGTH (MILES)	=	0.95
SUBBASIN SLOPE (PERCENT)	=	6.54
AVERAGE CURVE NUMBER	=	68.29
SUBBASIN LAG (HOURS)	=	0.63
NUMBER OF DATA CELLS	=	298.00

SCS CURVE NUMBER TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 1

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SUMMARY OF SUBBASIN DATA

SUBBASIN NUMBER	DRAINAGE AREA (SQ. MI.)	PERCENT OF WATERSHED	AVERAGE CURVE NUMBER	SUBBASIN LAG (HOURS)	STREAM LENGTH (MILES)	SUBBASIN SLOPE (PERCENT)
1.	0.71	5.58	68.3	0.63	0.95	6.54
2.	0.74	5.79	69.6	0.84	1.36	6.05
3.	0.58	4.55	73.7	0.77	1.25	5.12
4.	0.50	3.90	67.4	0.79	1.14	5.89
5.	0.22	1.76	70.6	0.53	0.76	5.71
6.	0.16	1.22	73.4	0.40	0.70	7.45
7.	0.82	6.44	71.3	0.79	1.40	6.55
8.	1.01	7.89	66.9	1.02	1.74	7.13
9.	0.66	5.21	69.9	0.72	1.33	7.86
10.	0.30	2.32	64.1	0.67	0.85	6.02
11.	0.44	3.45	72.0	0.65	1.00	5.39
12.	0.57	4.50	72.3	0.65	1.08	6.05
13.	1.15	8.97	70.4	0.86	1.46	6.30
14.	1.15	8.99	66.2	1.04	1.76	7.24
15.	0.30	2.32	62.7	0.82	1.14	6.95
16.	0.87	6.82	70.8	1.04	1.80	5.87
17.	0.59	4.59	65.3	0.89	1.59	8.69
18.	0.51	3.97	64.6	0.58	0.89	8.38
19.	0.32	2.47	63.2	0.79	1.14	7.2[illegible]
20.	0.36	2.79	64.6	0.53	0.87	9.73
21.	0.82	6.46	66.6	0.69	1.21	8.79

SCS CURVE NUMBER TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 1

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DATA FOR USE BY HEC-1 THROUGH HECDSS

HEC-1 STATION	DRAINAGE AREA (SQ.MI.)	SUBBASIN CURVE NUMBER	SUBBASIN LAG (HOURS)	SUBBASIN PERCENT IMPERV.	SNYDER"S LAG (TP) (HOURS)	SNYDER"S PEAKING COEF(CP)	HYDRO-GRAPH METHOD
TC-01	0.71	68.29	0.63	0.00	0.00	0.00	SCS CN
TC-02	0.74	69.58	0.84	0.00	0.00	0.00	SCS CN
TC-03	0.58	73.67	0.77	0.00	0.00	0.00	SCS CN
TC-04	0.50	67.43	0.79	0.00	0.00	0.00	SCS CN
TC-05	0.22	70.59	0.53	0.00	0.00	0.00	SCS CN
TC-06	0.16	73.40	0.40	0.00	0.00	0.00	SCS CN
TC-07	0.82	71.28	0.79	0.00	0.00	0.00	SCS CN
TC-08	1.01	66.92	1.02	0.00	0.00	0.00	SCS CN
TC-09	0.66	69.86	0.72	0.00	0.00	0.00	SCS CN
TC-10	0.30	64.10	0.67	0.00	0.00	0.00	SCS CN
TC-11	0.44	72.03	0.65	0.00	0.00	0.00	SCS CN
TC-12	0.57	72.32	0.65	0.00	0.00	0.00	SCS CN
TC-13	1.15	70.38	0.86	0.00	0.00	0.00	SCS CN
TC-14	1.15	66.16	1.04	0.00	0.00	0.00	SCS CN
TC-15	0.30	62.67	0.82	0.00	0.00	0.00	SCS CN
TC-16	0.87	70.84	1.04	0.00	0.00	0.00	SCS CN
TC-17	0.59	65.33	0.89	0.00	0.00	0.00	SCS CN
TC-18	0.51	64.63	0.58	0.00	0.00	0.00	SCS CN
TC-19	0.32	63.20	0.79	0.00	0.00	0.00	SCS CN
TC-20	0.36	64.[illegible]	0.53	0.00	0.00	0.00	SCS CN
TC-21	0.82	66.58	0.69	0.00	0.00	0.00	SCS CN

```
HECDSS FILE INFORMATION           HECDSS PATHNAMES FOR USE BY HEC-1
-----------------------           ---------------------------------

-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-01/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-02/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-03/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-04/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-05/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-06/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-07/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-08/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-09/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-10/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-11/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-12/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-13/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-14/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-15/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-16/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-17/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-18/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-19/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-20/HYDPAR///EXISTING LAND USE/
-----DSS---ZWRITE FILE  71, VERS.   1  /TRAIL CREEK/TC-21/HYDPAR///EXISTING LAND USE/

                -----DSS---ZCLOSE FILE   71
                           NO. RECORDS=      21
                           FILE SIZE=      2584 WORDS,     24 SECTORS
                           PERCENT INACTIVE=  0.00


+++++++++++++++++++
END OF RUN
HYDPAR PROGRAM STOP
+++++++++++++++++++
```

EXHIBIT 2

SNYDER'S LAG TECHNIQUE

HYDROLOGIC PARAMETERS

(HYDPAR)

SNYDER'S LAG TECHNIQUE — EXHIBIT 2

HYDPAR HYDROLOGIC PARAMETERS

APRIL 1985

EQ CARD VALUES

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   EQ0.9276000.387600-.003735
```

	CONST (C)	CONA (C1)	CONB (C2)
EQ VALUES	0.927600	0.387600	-.003735

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CALCULATION OF SNYDER"S LAG (TP)

$$TP\ (HOURS) = (C)(X)^{C1}\ (10)^{(C2)I}$$

WHERE ---

C = REGRESSION CONSTANT = 0.927600

$$X = (L)(Z)(S)^{-.5}$$

L = STREAM LENGTH (MILES)

Z = LCA (LENGTH TO CENTROID IN MILES)

S = STREAM SLOPE (FEET/MILE)

C1 = REGRESSION COEFFICIENT = 0.387600

C2 = REGRESSION COEFFICIENT = -.003735

I = PERCENT IMPERVIOUSNESS

SNYDER'S LAG TECHNIQUE EXHIBIT 2
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

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```
                    LAND USE CATEGORIES
                    -------------------
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   LU    1    36.    60.    73.    79.     3.NATURAL VEGETATION
   LU    2    39.    61.    74.    80.     8.DEVELOPED OPEN SPACE
   LU    3    47.    66.    77.    81.    20.LOW DENSITY RESIDENTIAL
   LU    4    61.    75.    83.    87.    28.MEDIUM DENSITY RESIDENTIAL
   LU    5    80.    85.    90.    95.    40.HIGH DENSITY RESIDENTIAL
   LU    6    67.    78.    85.    89.     3.AGRICULTURE
   LU    7    83.    88.    92.    96.    68.INDUSTRIAL
   LU    8    95.    96.    97.    98.    85.COMMERCIAL
   LU    9    49.    69.    79.    84.     3.PASTURE
   LU   10   100.   100.   100.   100.   100.WATEP BODIES
```

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PERCENT IMPERVIOUSNESS SUMMARY
WITH ASSOCIATED LAND USE CATEGORIES

LAND USE CATEGORY	TITLE	PERCENT IMPERVIOUSNESS
1	NATURAL VEGETATION	3.00
2	DEVELOPED OPEN SPACE	8.00
3	LOW DENSITY RESIDENTIAL	20.00
4	MEDIUM DENSITY RESIDENTIAL	28.00
5	HIGH DENSITY RESIDENTIAL	40.00
6	AGRICULTURE	3.00
7	INDUSTRIAL	68.00
8	COMMERCIAL	85.00
9	PASTURE	3.00
10	WATER BODIES	100.00

Exhibit 2

SNYDER'S LAG TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

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SUBBASIN PARAMETER CARDS

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   SB   1.    0.95    0.48   113.0   TC-01    0.40
   SB   2.    1.36    0.68    69.0   TC-02    0.43
   SB   3.    1.25    0.62    90.0   TC-03    0.43
   SB   4.    1.14    0.57   118.0   TC-04    0.43
   SB   5.    0.76    0.38   123.0   TC-05    0.43
   SB   6.    0.70    0.35   132.0   TC-06    0.43
   SB   7.    1.40    0.70   105.0   TC-07    0.40
   SB   8.    1.74    0.87    61.0   TC-08    0.43
   SB   9.    1.33    0.66   116.0   TC-09    0.43
   SB  10.    0.85    0.42    94.0   TC-10    0.40
   Sb  11.    1.00    0.50    80.0   TC-11    0.40
   SB  12.    1.08    0.54   105.0   TC-12    0.45
   SB  13.    1.46    0.73    78.0   TC-13    0.45
   SB  14.    1.76    0.88    80.0   TC-14    0.45
   SB  15.    1.14    0.57   106.0   TC-15    0.45
   SB  16.    1.80    0.90    78.0   TC-16    0.45
   SB  17.    1.59    0.80   101.0   TC-17    0.45
   SB  18.    0.89    0.44   149.0   TC-18    0.48
   SB  19.    1.14    0.57   118.0   TC-19    0.48
   SB  20.    0.87    0.44   138.0   TC-20    0.48
   SB  21.    1.21    0.60   143.0   TC-21    0.48
```

SUBBASIN SUMMARY TABLE

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HYDPAR SUBBASIN	STREAM LENGTH (MILES)	LENGTH TO CENTROID (MILES)	STREAM SLOPE (FT./MI.)	HEC-1 STATION	SNYDER"S CP
1.	0.95	0.48	113.0	TC-01	0.40
2.	1.36	0.68	69.0	TC-02	0.43
3.	1.25	0.62	90.0	TC-03	0.43
4.	1.14	0.57	118.0	TC-04	0.43
5.	0.76	0.38	123.0	TC-05	0.43
6.	0.70	0.35	132.0	TC-06	0.43
7.	1.40	0.70	105.0	TC-07	0.40
8.	1.74	0.87	61.0	TC-08	0.43
9.	1.33	0.66	116.0	TC-09	0.43
10.	0.85	0.42	94.0	TC-10	0.40
11.	1.00	0.50	80.0	TC-11	0.40
12.	1.08	0.54	105.0	TC-12	0.45
13.	1.46	0.73	78.0	TC-13	0.45
14.	1.76	0.88	80.0	TC-14	0.45
15.	1.14	0.57	106.0	TC-15	0.45

SNYDER'S LAG TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 2

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SUBBASIN 1.

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LAND USE CATEGORY	LAND USE	PERCENT IMPERVIOUSNESS	AREA IN ACRES	PERCENT OF SUBBASIN
1	NATURAL VEGETATION	3.00	223.38	48.99
3	LOW DENSITY RESIDENTIAL	20.00	68.85	15.10
6	AGRICULTURE	3.00	157.59	34.56
10	WATER BODIES	100.00	6.12	1.34
29	SUBBASIN AVERAGE	6.87	455.94	

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SUBBASIN 1. DATA	
DRAINAGE AREA (ACRES)	455.94
DRAINAGE AREA (SQ. MI.)	0.71
STREAM LENGTH (MILES)	0.95
LENGTH TO CENTROID (MILES)	0.48
STREAM SLOPE (FEET/MILE)	113.00
AVERAGE IMPERVIOUS. (PERCENT)	6.87
SUBBASIN TP (HOURS)	0.26
SNYDER"S PEAKING COEF. (CP)	0.40
NUMBER OF DATA CELLS	298.00

SNYDER'S LAG TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 2

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SUMMARY OF SUBBASIN DATA

SUBBASIN NUMBER	DRAINAGE AREA (SQ. MI.)	PERCENT OF WATERSHED	PERCENT IMPERVIOUS.	TP (HOURS)	SNYDER"S CP	STREAM LENGTH (MILES)	LCA-LENGTH TO CENTROID (MILES)	STREAM SLOPE (FT./MI.)
1.	0.71	5.58	6.87	0.26	0.40	0.95	0.48	113.
2.	0.74	5.79	3.61	0.38	0.43	1.36	0.68	69.
3.	0.58	4.55	3.00	0.34	0.43	1.25	0.62	90.
4.	0.50	3.90	7.01	0.29	0.43	1.14	0.57	118.
5.	0.22	1.76	3.00	0.22	0.43	0.76	0.38	123.
6.	0.16	1.22	3.00	0.20	0.43	0.70	0.35	132.
7.	0.82	6.44	3.38	0.36	0.40	1.40	0.70	105.
8.	1.01	7.89	6.34	0.47	0.43	1.74	0.87	61.
9.	0.66	5.21	11.27	0.32	0.43	1.33	0.66	116.
10.	0.30	2.32	3.14	0.25	0.40	0.85	0.42	94.
11.	0.44	3.45	3.00	0.30	0.40	1.00	0.50	80.
12.	0.57	4.50	10.42	0.28	0.45	1.08	0.54	105.
13.	1.15	8.97	7.93	0.38	0.45	1.46	0.73	78.
14.	1.15	8.99	5.33	0.45	0.45	1.76	0.88	80.
15.	0.30	2.32	3.00	0.31	0.45	1.14	0.57	106.
16.	0.87	6.82	9.90	0.44	0.45	1.80	0.90	78.
17.	0.59	4.59	4.76	0.40	0.45	1.59	0.80	101.
18.	0.51	3.97	12.49	0.22	0.48	0.89	0.44	149.
19.	0.32	2.47	8.17	0.29	0.48	1.14	0.57	118.
20.	0.36	2.79	13.21	0.22	0.48	0.87	0.44	138.
21.	0.82	6.46	16.71	0.27	0.48	1.21	0.60	143.

EXHIBIT 3

SAMPLE PROBLEM

SCS CURVE NUMBER TECHNIQUE

SAMPLE PROBLEM

SCS CURVE NUMBER TECHNIQUE

Problem Statement

Using the SCS Curve Number Technique, compute the existing hydrologic subbasin parameters for the Trail Creek Watershed utilizing values of average surface slope. Do not suppress any of the subbasin output.

The format of the data file in the Trail Creek DATA BANK is (12F4.0, 2F8.2, 2F4.0, 2F2.0). The curve numbers that have been adopted for the land use categories are tabulated in Table 1. Table 2 contains the stream length and the stream slope for each subbasin. The average slope values are given in Table 3; and Table 4 is a listing of the data base file incorporated in the Trail Creek Watershed.

Description of Input Requirements

The key input variables for this computation are IANL (J1.1), described in detail later in Exhibit 5, which identifies the type of calculation, and ISLP (J2.7) for indicating inclusion of the SL record(s). It should be noted that the the alphanumeric characters within the parentheses following the variable name refer to particular input records and related record fields. As an example, the first two alphanumeric characters of (J1.1) indicate the J1-record and the character(s) following the decimal point indicates a particular field (or record column group).

The Curve Number values (LU records) are taken from Table 1. Subbasin data, Table 2, are coded on SB records, while the average slope values, Table 3, are input on SL record(s).

Exhibit 3

Discussion of Results

Average surface slope values were input on the SL record to satisfy the SCS equation requirement for slope input. The output for this sample problem includes Specific Subbasin Data for Subbasin 1 (page 55) and the Summary of Subbasin Data for the entire watershed (page 56). The subbasin averages in Specific Subbasin Data reflect a weighting of land use values based on the amount of subbasin coverage for a particular land use category. On the page of Specific Subbasin Data, the subbasin area is defined by the following units: acres, square miles and number of grid cells. The last page of output, Summary of Subbasin Data, summarizes calculated and input data for each subbasin.

TABLE 1

CURVE NUMBER TABLE

Land Use Categories	Hydrologic Soil Group A	B	C	D
1	36	60	73	79
2	39	61	74	80
3	47	66	77	81
4	61	75	83	87
5	80	85	90	95
6	67	78	85	89
7	83	88	92	96
8	95	96	97	98
9	49	69	79	84
10	100	100	100	100

TABLE 2

SUBBASIN DATA

Subbasin	Stream length (miles)	LCA (miles)	Stream Slope (feet/mile)
1	.95	.48	113.
2	1.36	.68	69.
3	1.25	.62	90.
4	1.14	.57	118.
5	.76	.38	123.
6	.70	.35	132.
7	1.40	.70	105.
8	1.74	.87	61.
9	1.33	.66	116.
10	.85	.42	94.
11	1.00	.50	80.
12	1.08	.54	105.
13	1.46	.73	78.
14	1.76	.88	80.
15	1.14	.57	106.
16	1.80	.90	78.
17	1.59	.80	101.
18	.89	.44	149.
19	1.14	.57	118.
20	.87	.44	138.
21	1.21	.60	143.

Exhibit 3

TABLE 3

AVERAGE SLOPE

Slope Category	Average Slope
1	1.0
2	4.0
3	8.0
4	13.0
5	20.0
6	35.0
7	50.0

Exhibit 3

TABLE 4

DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1		GRID CELL ROW
	1	Row 1
	2-92	Rows 2-92
2		GRID CELL COLUMN
	1	Column 1
	2-129	Columns 2-129
4		HYDROLOGIC SOIL GROUPS
	1	Subbasin 1
	2-21	Subbasins 2-21
7		HYDROLOGIC SOIL GROUPS
	1	Group A (Low Runoff Potential)
	2	Group B (Moderate Infiltration Rates)
	3	Group C (Slow Infiltration Rates)
	4	Group D (High Runoff Potential)
8		LAND SURFACE SLOPE
	1	0 to 3 percent slope
	2	3 to 5 percent slope
	3	5 to 10 percent slope
	4	10 to 15 percent slope
	5	15 to 25 percent slope
	6	25 to 45 percent slope
	7	Greater than 45 percent slope
10		EXISTING LAND USE
	1	Natural vegetation
	2	Developed open space
	3	Low density residential
	4	Medium density residential
	5	High density residential
	6	Agricultural
	7	Industrial
	8	Commercial
	9	Pasture
	10	Water bodies

Exhibit 3

SCS CURVE NUMBER TECHNIQUE EXHIBIT 3
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

LIST OF INPUT CARDS FOR THIS RUN

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890

T1                           SCS CURVE NUMBER TECHNIQUE         EXHIBIT 3
T2                          HYDPAR HYDROLOGIC PARAMETERS
T3                                     APRIL 1985
J1     0       1       1      92     129    1.53
J2    18      21       4      10      10       7       8       7
FT(12F4.0,2F8.2,2F4.0,2F2.0)
SL   1.0     4.0     8.0    13.0    20.0    35.0    50.0
LU     1      36      60      73      79       3NATURAL VEGETATION
LU     2      39      61      74      80       8DEVELOPED OPEN SPACE
LU     3      47      66      77      81      20LOW DENSITY RESIDENTIAL
LU     4      61      75      83      87      28MEDIUM DENSITY RESIDENTIAL
LU     5      80      85      90      95      40HIGH DENSITY RESIDENTIAL
LU     6      67      78      85      89       3AGRICULTURE
LU     7      83      88      92      96      68INDUSTRIAL
LU     8      95      96      97      98      85COMMERCIAL
LU     9      49      69      79      84       3PASTURE
LU    10     100     100     100     100     100WATER BODIES
SB     1     .95     .48     113   TC-01
SB     2    1.36     .68      69   TC-02
SB     3    1.25     .62      90   TC-03
SB     4    1.14     .57     118   TC-04
SB     5     .76     .38     123   TC-05
SB     6     .70     .35     132   TC-06
SB     7    1.40     .70     105   TC-07
SB     8    1.74     .87      61   TC-08
SB     9    1.33     .66     116   TC-09
SB    10     .85     .42      94   TC-10
SB    11    1.00     .50      80   TC-11
SB    12    1.08     .54     105   TC-12
SB    13    1.46     .73      78   TC-13
SB    14    1.76     .88      80   TC-14
SB    15    1.14     .57     106   TC-15
SB    16    1.80     .90      78   TC-16
SB    17    1.59     .80     101   TC-17
SB    18     .89     .44     149   TC-18
SB    19    1.14     .57     118   TC-19
SB    20     .87     .44     138   TC-20
SB    21    1.21     .60     143   TC-21
END
```

SCS CURVE NUMBER TECHNIQUE EXHIBIT 3
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

J1 CARD

```
-------
CC 1234567890123456789012345678901234567890123456789012345678901234567890
   J1     0       1       1      92     129    1.53
```

J1 JOB PARAMETERS

```
----------------
IANL   =      0, CURVE NUMBER AND SCS LAG WILL BE COMPUTED FOR EACH SUBBASIN
ILUPRT =      1, LIST INPUT CARDS + NORMAL PRINTOUT
IFMT   =      1, GRID CELL DATA BANK IS FORMATTED
NROW   =     92, TOTAL NUMBER OF ROWS IN DATA BANK
NCOL   =    129, TOTAL NUMBER OF COLUMNS IN DATA BANK
SIZE   =   1.53, THE SIZE OF THE GRID CELL IS IN ACRES
```

```
                    SCS CURVE NUMBER TECHNIQUE          EXHIBIT 3
                   HYDPAR HYDROLOGIC PARAMETERS
                            APRIL 1985

              J2 CARD
              -------
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   J2    18      21       4      10      10       7       8       7

              J2 JOB PARAMETERS
              -----------------

              NVAR   =    18, THE NUMBER OF DATA VARIABLES PER GRID CELL RECORD

              NSUB   =    21, THE NUMBER OF SUBBASINS ANALYZED IN THIS RUN

              IBS    =     4, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE SUBBASIN CODE

              NLUSE  =    10, THE NUMBER OF LAND USE CATEGORIES IN THE GRID CELL DATA BANK

              ILD    =    10, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE LAND USE PATTERN TO BE ANALYZED

              NSLP   =     7, THE NUMBER OF SLOPE CLASSES FOR CURVE NUMBER ANALYSIS

              ISLP   =     8, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE SCS LAND SURFACE SLOPE CODE

              IHYO   =     7, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE HYDROLOGIC SOIL GROUP CODE

              FORMAT CARD
              -----------
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   FT(12F4.0,2F8.2,2F4.0,2F2.0)
```

SCS CURVE NUMBER TECHNIQUE — EXHIBIT 3

HYDPAR HYDROLOGIC PARAMETERS

APRIL 1985

LAG EQUATION

****

$$\text{LAG (HOURS)} = \frac{(L)^{0.8}\,(S+1)^{0.7}}{(1900)(Y)^{0.5}}$$

WHERE --

L = THE HYDRAULIC LENGTH OF WATERSHED IN FEET

Y = AVERAGE SUBBASIN LAND SLOPE IN PER CENT

S = (1000/CN)-10
WHERE CN IS THE CURVE NUMBER

THE SUBBASIN CURVE NUMBER IS A WEIGHTED AVERAGE FOR THE LAND USE WITHIN THE HYDROLOGIC SOIL GROUPS. SUBBASIN SLOPE IS A SIMPLE AVERAGE AND SUBBASIN STREAM SLOPE AND LENGTH ARE DETERMINED EXTERNALLY AND DIRECTLY INPUT.

SCS CURVE NUMBER TECHNIQUE   EXHIBIT 3
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

SLOPE CLASS AVERAGES

```
CC 1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
  SL    1.      4.      8.     13.     20.     35.     50.      0.      0.      0.
```

SLOPE CLASS	AVERAGE PERCENT
1	1.000
2	4.000
3	8.000
4	13.000
5	20.000
6	35.000
7	50.000

SCS·CURVE NUMBER TECHNIQUE EXHIBIT 3
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

LAND USE CATEGORIES

CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890

LU	1	36.	60.	73.	79.	3.NATURAL VEGETATION
LU	2	39.	61.	74.	80.	8.DEVELOPED OPEN SPACE
LU	3	47.	66.	77.	81.	20.LOW DENSITY RESIDENTIAL
LU	4	61.	75.	83.	87.	28.MEDIUM DENSITY RESIDENTIAL
LU	5	80.	85.	90.	95.	40.HIGH DENSITY RESIDENTIAL
LU	6	67.	78.	85.	89.	3.AGRICULTURE
LU	7	83.	88.	92.	96.	68.INDUSTRIAL
LU	8	95.	96.	97.	96.	85.COMMERCIAL
LU	9	49.	69.	79.	84.	3.PASTURE
LU	10	100.	100.	100.	100.	100.WATER BODIES

CURVE NUMBER SUMMARY WITH
ASSOCIATED LAND USE CATEGORIES

LAND USE CATEGORY	TITLE	HYDROLOGIC SOIL GROUP A	B	C	D
1	NATURAL VEGETATION	36.	60.	73.	79.
2	DEVELOPED OPEN SPACE	39.	61.	74.	80.
3	LOW DENSITY RESIDENTIAL	47.	66.	77.	81.
4	MEDIUM DENSITY RESIDENTIAL	61.	75.	83.	87.
5	HIGH DENSITY RESIDENTIAL	80.	85.	90.	95.
6	AGRICULTURE	67.	78.	85.	89.
7	INDUSTRIAL	83.	88.	92.	96.
8	COMMERCIAL	95.	96.	97.	98.
9	PASTURE	49.	69.	79.	84.
10	WATER BODIES	100.	100.	100.	100.

Exhibit 3

SCS CURVE NUMBER TECHNIQUE — EXHIBIT 3

HYDPAR HYDROLOGIC PARAMETERS

APRIL 1985

SUBBASIN PARAMETER CARDS

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   SB    1.    0.95    0.48   113.0   TC-01    0.00
   SB    2.    1.36    0.68    69.0   TC-02    0.00
   SB    3.    1.25    0.62    90.0   TC-03    0.00
   SB    4.    1.14    0.57   118.0   TC-04    0.00
   SB    5.    0.76    0.38   123.0   TC-05    0.00
   SB    6.    0.70    0.35   132.0   TC-06    0.00
   SB    7.    1.40    0.70   105.0   TC-07    0.00
   SB    8.    1.74    0.87    61.0   TC-08    0.00
   SB    9.    1.33    0.66   116.0   TC-09    0.00
   SB   10.    0.85    0.42    94.0   TC-10    0.00
   SB   11.    1.00    0.50    80.0   TC-11    0.00
   SB   12.    1.08    0.54   105.0   TC-12    0.00
   SB   13.    1.46    0.73    78.0   TC-13    0.00
   SB   14.    1.76    0.88    80.0   TC-14    0.00
   SB   15.    1.14    0.57   106.0   TC-15    0.00
   SB   16.    1.80    0.90    78.0   TC-16    0.00
   SB   17.    1.59    0.80   101.0   TC-17    0.00
   SB   18.    0.89    0.44   149.0   TC-18    0.00
   SB   19.    1.14    0.57   118.0   TC-19    0.00
   SB   20.    0.87    0.44   138.0   TC-20    0.00
   SB   21.    1.21    0.60   143.0   TC-21    0.00
```

SUBBASIN SUMMARY TABLE

HYDPAR SUBBASIN	STREAM LENGTH (MILES)	LENGTH TO CENTROID (MILES)	STREAM SLOPE (FT./MI.)	HEC-1 STATION	SNYDER"S CP
1.	0.95	0.48	113.0	TC-01	0.00
2.	1.36	0.68	69.0	TC-02	0.00
3.	1.25	0.62	90.0	TC-03	0.00
4.	1.14	0.57	118.0	TC-04	0.00
5.	0.76	0.38	123.0	TC-05	0.00
6.	0.70	0.35	132.0	TC-06	0.00
7.	1.40	0.70	105.0	TC-07	0.00
8.	1.74	0.87	61.0	TC-08	0.00
9.	1.33	0.66	116.0	TC-09	0.00
10.	0.85	0.42	94.0	TC-10	0.00
11.	1.00	0.50	80.0	TC-11	0.00
12.	1.08	0.54	105.0	TC-12	0.00
13.	1.46	0.73	78.0	TC-13	0.00
14.	1.76	0.88	80.0	TC-14	0.00
15.	1.14	0.57	106.0	TC-15	0.00
16.	1.80	0.90	78.0	TC-16	0.00
17.	1.59	0.80	101.0	TC-17	0.00
18.	0.89	0.44	149.0	TC-18	0.00
19.	1.14	0.57	118.0	TC-19	0.00
20.	0.87	0.44	138.0	TC-20	0.00
21.	1.21	0.60	143.0	TC-21	0.00

SCS CURVE NUMBER TECHNIQUE
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

EXHIBIT 3

SUBBASIN 1.

LAND USE CATEGORY	LAND USE	AVE CURVE NO.	SURFACE SLOPE (PERCENT)	AREA IN ACRES	PERCENT OF SUBBASIN
1	NATURAL VEGETATION	61.0	7.25	223.38	48.99
3	LOW DENSITY RESIDENTIAL	67.0	4.82	68.85	15.10
6	AGRICULTURE	78.0	6.49	157.59	34.56
10	WATER BODIES	100.0	1.00	6.12	1.34
	SUBBASIN AVERAGE	68.3	6.54	455.94	

SUBBASIN 1. DATA		
DRAINAGE AREA (ACRES)	=	455.94
DRAINAGE AREA (SQ. MI.)	=	0.71
STREAM LENGTH (MILES)	=	0.95
SUBBASIN SLOPE (PERCENT)	=	6.54
AVERAGE CURVE NUMBER	=	68.29
SUBBASIN LAG (HOURS)	=	0.63
NUMBER OF DATA CELLS	=	298.00

SCS CURVE NUMBER TECHNIQUE — EXHIBIT 3

HYDPAR HYDROLOGIC PARAMETERS

APRIL 1985

SUMMARY OF SUBBASIN DATA

SUBBASIN NUMBER	DRAINAGE AREA (SQ. MI.)	PERCENT OF WATERSHED	AVERAGE CURVE NUMBER	SUBBASIN LAG (HOURS)	STREAM LENGTH (MILES)	SUBBASIN SLOPE (PERCENT)
1.	0.71	5.58	68.3	0.63	0.95	6.54
2.	0.74	5.79	69.6	0.84	1.36	6.05
3.	0.58	4.55	73.7	0.77	1,25	5.12
4.	0.50	3.90	67.4	0.79	1.14	5.89
5.	0.22	1.76	70.6	0.53	0.76	5.71
6.	0.16	1.22	73.4	0.40	0.70	7.45
7.	0.82	6.44	71.3	0.79	1.40	6.55
8.	1.01	7.89	66.9	1.02	1.74	7.13
9.	0.66	5.21	69.9	0.72	1.33	7.86
10.	0.30	2.32	64.1	0.67	0.85	6.02
11.	0.44	3.45	72.0	0.65	1.00	5.39
12.	0.57	4.50	72.3	0.65	1.08	6.05
13.	1.15	8.97	70.4	0.86	1.46	6.30
14.	1.15	8.99	66.2	1.04	1.76	7.24
15.	0.30	2.32	62.7	0.82	1.14	6.95
16.	0.87	6.82	70.8	1.04	1.80	5.87
17.	0.59	4.59	65.3	0.89	1.59	8.69
18.	0.51	3.97	64.6	0.58	0.89	8.38
19.	0.32	2.47	63.2	0.79	1.14	7.29
20.	0.36	2.79	64.6	0.53	0.87	9.73
21.	0.82	6.46	66.6	0.69	1.21	8.79

EXHIBIT 4

SAMPLE PROBLEM

PERCENT IMPERVIOUS AND SNYDER'S METHOD

SAMPLE PROBLEM

PERCENT IMPERVIOUS AND SNYDER'S METHOD

Problem Statement

Calculate the hydrologic subbasin parameters, percent impervious surface and basin lag for the Trail Creek Watershed under existing conditions using the weighted average technique for computing imperviousness and the regression equation form, equation 3. Use Table 1 to assign values of percent imperviousness to each of the ten land use categories and Table 2 to define the necessary physiographic characteristics utilized in the regression equation. (Table 3 is a listing of the data base file used in the Trail Creek Watershed).

Description of Input Requirements

Land surface slope values (different from stream slope values) are not necessary input for this computation. The regression coefficients are input on the EQ record, providing the necessary equation values. Percent imperviousness values are provided for each land use category on the LU records, one value for each category indicated in NLUSE (J2.4). The SB records contain particular subbasin information for each subbasin to be analyzed, NSUB (J2.2).

Discussion of Results

Output for subbasin 1 and the summarized data for the entire watershed has been provided on the following pages. Since no land slope values (SCS slope class averages) were input, the specific subbasin data and the final summary printout incluce a 'not available' (N/A) indicator under SURFACE and SUBBASIN SLOPE. (If this summary is desired and land slope values are in the data bank, input the necessary data as done in the previous sample problem, Exhibit 3). The 'Summary of Subbasin Data' provides a condensed listing of data for each subbasin. Some of the data shown may be stored for subsequent use in the HEC-1 Flood Hydrograph Package.

Exhibit 4

TABLE 1

PERCENTAGE OF IMPERVIOUS SURFACE WITHIN EACH LAND USE CATEGORY

Land Use Category	Imperviousness (%)
1	3.
2	8.
3	20.
4	28.
5	40.
6	3.
7	68.
8	85.
9	3.
10	100.

TABLE 2

SUBBASIN DATA

Subbasin	Stream Length (Miles)	LCA (Miles)	Stream Slope (feet/mile)
1	.95	.48	113.
2	1.36	.68	69.
3	1.25	.62	90.
4	1.14	.57	118.
5	.76	.38	123.
6	.70	.35	132.
7	1.40	.70	105.
8	1.74	.87	61.
9	1.33	.66	116.
10	.85	.42	94.
11	1.00	.50	80.
12	1.08	.54	105.
13	1.46	.73	78.
14	1.76	.88	80.
15	1.14	.57	106.
16	1.80	.90	78.
17	1.59	.80	101.
18	.89	.44	149.
19	1.14	.57	118.
20	.87	.44	138.
21	1.21	.60	143.

Exhibit 4

TABLE 3

DATA BASE FILE DIRECTORY
FOR
THE TRAIL CREEK WATERSHED

Data Variable Code	Data Category Code	Identifying Title
1		GRID CELL ROW
	1	Row 1
	2-92	Rows 2-92
2		GRID CELL COLUMN
	1	Column 1
	2-129	Columns 2-129
4		HYDROLOGIC SOIL GROUPS
	1	Subbasin 1
	2-21	Subbasins 2-21
7		HYDROLOGIC SOIL GROUPS
	1	Group A (Low Runoff Potential)
	2	Group B (Moderate Infiltration Rates)
	3	Group C (Slow Infiltration Rates)
	4	Group D (High Runoff Potential)
8		LAND SURFACE SLOPE
	1	0 to 3 percent slope
	2	3 to 5 percent slope
	3	5 to 10 percent slope
	4	10 to 15 percent slope
	5	15 to 25 percent slope
	6	25 to 45 percent slope
	7	Greater than 45 percent slope
10		EXISTING LAND USE
	1	Natural vegetation
	2	Developed open space
	3	Low density residential
	4	Medium density residential
	5	High density residential
	6	Agricultural
	7	Industrial
	8	Commercial
	9	Pasture
	10	Water bodies

Exhibit 4

SNYDER'S LAG TECHNIQUE   EXHIBIT 4
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

LIST OF INPUT CARDS FOR THIS RUN

```
CC 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890

T1                            SNYDER'S LAG TECHNIQUE           EXHIBIT 4
T2                          HYDPAR HYDROLOGIC PARAMETERS
T3                                   APRIL 1985
J1     1       1       1      92     129    1.53
J2    18      21       4      10      10       0       0       0
FT(12F4.0,2F8.2,2F4.0,2F2.0                                              )
EQ.92760  .38760-.003735
LU     1      36      60      73      79      3NATURAL VEGETATION
LU     2      39      61      74      80      8DEVELOPED OPEN SPACE
LU     3      47      66      77      81     20LOW DENSITY RESIDENTIAL
LU     4      61      75      83      87     28MEDIUM DENSITY RESIDENTIAL
LU     5      80      85      90      95     40HIGH DENSITY RESIDENTIAL
LU     6      67      78      85      89      3AGRICULTURE
LU     7      83      88      92      96     68INDUSTRIAL
LU     8      95      96      97      98     85COMMERCIAL
LU     9      49      69      79      84      3PASTURE
LU    10     100     100     100     100    100WATER BODIES
SB     1     .95     .48     113   TC-01     .40
SB     2    1.36     .68      69   TC-02     .43
SB     3    1.25     .62      90   TC-03     .43
SB     4    1.14     .57     118   TC-04     .43
SB     5     .76     .38     123   TC-05     .43
SB     6     .70     .35     132   TC-06     .43
SB     7    1.40     .70     105   TC-07     .40
SB     8    1.74     .87      61   TC-08     .43
SB     9    1.33     .66     116   TC-09     .43
SB    10     .85     .42      94   TC-10     .40
SB    11    1.00     .50      80   TC-11     .40
SB    12    1.08     .54     105   TC-12     .45
SB    13    1.46     .73      78   TC-13     .45
SB    14    1.76     .88      80   TC-14     .45
SB    15    1.14     .57     106   TC-15     .45
SB    16    1.80     .90      78   TC-16     .45
SB    17    1.59     .80     101   TC-17     .45
SB    18     .89     .44     149   TC-18     .48
SB    19    1.14     .57     118   TC-19     .48
SB    20     .87     .44     138   TC-20     .48
SB    21    1.21     .60     143   TC-21     .48
END
```

```
                    SNYDER'S LAG TECHNIQUE          EXHIBIT 4
                  HYDPAR HYDROLOGIC PARAMETERS
                          APRIL 1985


               J1 CARD
               -------
CC 1234567890123456789012345678901234567890123456789012345678901234567890
   J1     1       1       1      92     129    1.53

               J1 JOB PARAMETERS
               -----------------

               IANL   =       1, IMPERVIOUSNESS AND SYNDER"S LAG WILL BE COMPUTED FOR EACH SUBBASIN

               ILUPRT =       1, LIST INPUT CARDS + NORMAL PRINTOUT

               IFMT   =       1, GRID CELL DATA BANK IS FORMATTED

               NROW   =      92, TOTAL NUMBER OF ROWS IN DATA BANK

               NCOL   =     129, TOTAL NUMBER OF COLUMNS IN DATA BANK

               SIZE   =    1.53, THE SIZE OF THE GRID CELL IS IN ACRES
```

SNYDER'S LAG TECHNIQUE EXHIBIT 4
HYDPAR HYDROLOGIC PARAMETERS
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```
                         J2 CARD
                         -------
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   J2   18      21       4       10      10       0       0       0

                         J2 JOB PARAMETERS
                         -----------------

                         NVAR  =     18, THE NUMBER OF DATA VARIABLES PER GRID CELL RECORD

                         NSUB  =     21, THE NUMBER OF SUBBASINS ANALYZED IN THIS RUN

                         IBS   =      4, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE SUBBASIN CODE

                         NLUSE =     10, THE NUMBER OF LAND USE CATEGORIES IN THE GRID CELL DATA BANK

                         ILD   =     10, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE LAND USE PATTERN TO BE ANALYZED

                         NSLP  =      0, THE NUMBER OF SLOPE CLASSES FOR CURVE NUMBER ANALYSIS

                         ISLP  =      0, NO SLOPE VARIABLE

                         INYO  =      0, IS THE SEQUENCE NUMBER OF THE DATA BANK WHICH IS THE HYDROLOGIC SOIL GROUP CODE

                         FORMAT CARD
                         -----------
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   FT(12F4.0,2F8.2,2F4.0,2F2.0                                                   )
```

SNYDER'S LAG TECHNIQUE EXHIBIT 4
HYDPAR HYDROLOGIC PARAMETERS
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EQ CARD VALUES

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   EQ0.9276000.387600-.003735
```

	CONST (C)	CONA (C1)	CONB (C2)
EQ VALUES	0.927600	U.387600	-.003735

CALCULATION OF SNYDER"S LAG (TP)

$$TP\ (HOURS) = (C)(X)^{C1}\,(10)^{(C2)I}$$

WHERE ---

C = REGRESSION CONSTANT = 0.927600

$$X = (L)(Z)(S)^{-.5}$$

L = STREAM LENGTH (MILES)

Z = LCA (LENGTH TO CENTROID IN MILES)

S = STREAM SLOPE (FEET/MILE)

C1 = REGRESSION COEFFICIENT = 0.387600

C2 = REGRESSION COEFFICIENT = -.003735

I = PERCENT IMPERVIOUSNESS

```
                         SNYDER'S LAG TECHNIQUE          EXHIBIT 4
                       HYDPAR HYDROLOGIC PARAMETERS
                               APRIL 1985

                LAND USE CATEGORIES
                -------------------
CC 1234567890123456789012345678901234567890123456789012345678901234567890
  LU    1    36.    60.    73.    79.      3.NATURAL VEGETATION
  LU    2    39.    61.    74.    80.      8.DEVELOPED OPEN SPACE
  LU    3    47.    66.    77.    81.     20.LOW DENSITY RESIDENTIAL
  LU    4    61.    75.    83.    87.     28.MEDIUM DENSITY RESIDENTIAL
  LU    5    80.    85.    90.    95.     40.HIGH DENSITY RESIDENTIAL
  LU    6    67.    78.    85.    89.      3.AGRICULTURE
  LU    7    83.    88.    92.    96.     68.INDUSTRIAL
  LU    8    95.    96.    97.    98.     85.COMMERCIAL
  LU    9    49.    69.    79.    84.      3.PASTURE
  LU   10   100.   100.   100.   100.    100.WATER BODIES
```

PERCENT IMPERVIOUSNESS SUMMARY
WITH ASSOCIATED LAND USE CATEGORIES

LAND USE CATEGORY	TITLE	PERCENT IMPERVIOUSNESS
1	NATURAL VEGETATION	3.00
2	DEVELOPED OPEN SPACE	8.00
3	LOW DENSITY RESIDENTIAL	20.00
4	MEDIUM DENSITY RESIDENTIAL	28.00
5	HIGH DENSITY RESIDENTIAL	40.00
6	AGRICULTURE	3.00
7	INDUSTRIAL	68.00
8	COMMERCIAL	85.00
9	PASTURE	3.00
10	WATER BODIES	100.00

Exhibit 4

SNYDER'S LAG TECHNIQUE EXHIBIT 4
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

SUBBASIN PARAMETER CARDS

```
CC 12345678901234567890123456789012345678901234567890123456789012345678901234567890
   SB   1.    0.95    0.48   113.0    TC-01     0.40
   SB   2.    1.36    0.68    69.0    TC-02     0.43
   SB   3.    1.25    0.62    90.0    TC-03     0.43
   SB   4.    1.14    0.57   118.0    TC-04     0.43
   SB   5.    0.76    0.38   123.0    TC-05     0.43
   SB   6.    0.70    0.35   132.0    TC-06     0.43
   SB   7.    1.40    0.70   105.0    TC-07     0.40
   SB   8.    1.74    0.87    61.0    TC-08     0.43
   SB   9.    1.33    0.66   116.0    TC-09     0.43
   SB  10.    0.85    0.42    94.0    TC-10     0.40
   SB  11.    1.00    0.50    80.0    TC-11     0.40
   SB  12.    1.08    0.54   105.0    TC-12     0.45
   SB  13.    1.46    0.73    78.0    TC-13     0.45
   SB  14.    1.76    0.88    80.0    TC-14     0.45
   SB  15.    1.14    0.57   106.0    TC-15     0.45
   SB  16.    1.80    0.90    78.0    TC-16     0.45
   SB  17.    1.59    0.80   101.0    TC-17     0.45
   SB  18.    0.89    0.44   149.0    TC-18     0.48
   SB  19.    1.14    0.57   118.0    TC-19     0.48
   SB  20.    0.87    0.44   138.0    TC-20     0.48
   SB  21.    1.21    0.60   143.0    TC-21     0.48
```

SUBBASIN SUMMARY TABLE

HYDPAR SUBBASIN	STREAM LENGTH (MILES)	LENGTH TO CENTROID (MILES)	STREAM SLOPE (FT./MI.)	HEC-1 STATION	SNYDER"S CP
1.	0.95	0.48	113.0	TC-01	0.40
[illegible].	1.36	0.68	69.0	TC-02	0.43
3.	1.25	0.62	90.0	TC-03	0.43
4.	1.14	0.57	118.0	TC-04	0.43
5.	0.76	0.38	123.0	TC-05	0.43
6.	0.70	0.35	132.0	TC-06	0.43
7.	1.40	0.70	105.0	TC-07	0.40
8.	1.74	0.87	61.0	TC-08	0.43
9.	1.33	0.66	116.0	TC-09	0.43
10.	0.85	0.42	94.0	TC-10	0.40
11.	1.00	0.50	80.0	TC-11	0.40
12.	1.08	0.54	105.0	TC-12	0.45
13.	1.46	0.73	78.0	TC-13	0.45
14.	1.76	0.88	80.0	TC-14	0.45
15.	1.14	0.57	106.0	TC-15	0.45
16.	1.80	0.90	78.0	TC-16	0.45
17.	1.59	0.80	101.0	TC-17	0.45
18.	0.89	0.44	149.0	TC-18	0.48
19.	1.14	0.57	118.0	TC-19	0.48
20.	0.87	0.44	138.0	TC-20	0.48
21.	1.21	0.60	143.0	TC-21	0.48

SNYDER'S LAG TECHNIQUE EXHIBIT 4
HYDPAR HYDROLOGIC PARAMETERS
APRIL 1985

SUBBASIN 1.

LAND USE CATEGORY	LAND USE	PERCENT IMPERVIOUSNESS	AREA IN ACRES	PERCENT OF SUBBASIN
1	NATURAL VEGETATION	3.00	223.38	48.99
3	LOW DENSITY RESIDENTIAL	20.00	68.85	15.10
6	AGRICULTURE	3.00	157.59	34.56
10	WATER BODIES	100.00	6.12	1.34
	SUBBASIN AVERAGE	6.87	455.94	

SUBBASIN 1. DATA		
DRAINAGE AREA (ACRES)	=	455.94
DRAINAGE AREA (SQ. MI.)	=	0.71
STREAM LENGTH (MILES)	=	0.95
LENGTH TO CENTROID (MILES)	=	0.48
STREAM SLOPE (FEET/MILE)	=	113.00
AVERAGE IMPERVIOUS. (PERCENT)	=	6.87
SUBBASIN TP (HOURS)	=	0.26
SNYDER"S PEAKING COEF. (CP)	=	0.40
NUMBER OF DATA CELLS	=	298.00

SNYDER'S LAG TECHNIQUE HYDPAK HYDROLOGIC PARAMETERS APRIL 1985 — EXHIBIT 4

SUMMARY OF SUBBASIN DATA

SUBBASIN NUMBER	DRAINAGE AREA (SQ. MI.)	PERCENT OF WATERSHED	PERCENT IMPERVIOUS.	TP (HOURS)	SNYDER"S CP	STREAM LENGTH (MILES)	LCA-LENGTH TO CENTROID (MILES)	STREAM SLOPE (FT./MI.)
1.	0.71	5.58	6.87	0.26	0.40	0.95	0.48	113.
2.	0.74	5.79	3.61	0.38	0.43	1.36	0.68	69.
3.	0.58	4.55	3.00	0.34	0.43	1.25	0.62	90.
4.	0.50	3.90	7.01	0.29	0.43	1.14	0.57	118.
5.	0.22	1.76	3.00	0.22	0.43	0.76	0.38	123.
6.	0.16	1.22	3.00	0.20	0.43	0.70	0.35	132.
7.	0.82	6.44	3.38	0.36	0.40	1.40	0.70	105.
8.	1.01	7.89	6.34	0.47	0.43	1.74	0.87	61.
9.	0.66	5.21	11.27	0.32	0.43	1.33	0.66	116.
10.	0.30	2.32	3.14	0.25	0.40	0.85	0.42	94.
11.	0.44	3.45	3.00	0.30	0.40	1.00	0.50	80.
12.	0.57	4.50	10.42	0.28	0.45	1.08	0.54	105.
13.	1.15	8.97	7.93	0.38	0.45	1.46	0.73	78.
14.	1.15	8.99	5.33	0.45	0.45	1.76	0.88	80.
15.	0.30	2.32	3.00	0.31	0.45	1.14	0.57	106.
16.	0.87	6.82	9.90	0.44	0.45	1.80	0.90	78.
17.	0.59	4.59	4.76	0.40	0.45	1.59	0.80	101.
18.	0.51	3.97	12.49	0.22	0.48	0.89	0.44	149.
19.	0.32	2.47	8.17	0.29	0.48	1.14	0.57	118.
20.	0.36	2.79	13.21	0.22	0.48	0.87	0.44	138.
21.	0.82	6.46	16.71	0.27	0.48	1.21	0.60	143.

EXHIBIT 5

INPUT DESCRIPTION

HYDROLOGIC PARAMETERS

(HYDPAR)

EXHIBIT 5

INPUT DESCRIPTION
HYDROLOGIC PARAMETERS
(HYDPAR)

This exhibit provides a detailed description of the HYDPAR data input requirements, by record and data variable. Previous versions of this document referred to each data record as a card. The majority of new users no longer use cards but instead use utility programs, such as text editors, word processors, or spreadsheets, to produce the input data file for their programs. The term "card" in the original document has been changed to the term "record" in this version. Each record in the HYDPAR program is the equivalent of a line to a text editor program, a line with carriage return to a word processing program, or a row to a spreadsheet program.

Each record contains 11 fields, field 0 through field 10. Field 0 (zero) refers to column positions 1 and 2 and is reserved for the record identifier. Field 1 ranges from column 3-8; fields 2-10 contain eight columns each (9-16, 17-24,...,73-80). The field number designates the location of the variable on each input record. An abbreviated field location nomenclature is used to identify the field location. The record name is followed by a decimal point and the field number. For example, J1.3 refers to the third field on the J1 record. A field on a record may contain data in only a part of the field. In those cases, the location is referred to as columns, shown in parentheses. For example, field 6 on the ZW record contains the variable IYR in columns 45-48. All variables beginning with I, J, K, L, M, and N should have integer values (no decimal point) and be right-justified (the values shifted to the right within each field). A "+" sign under the value heading indicates the placement of a positive numerical value in the field. A "-" sign indicates a negative numerical value in that field. "AN" means that a combination of alphanumeric characters is allowed. When a number does not have a sign, a positive value will be assumed. In general, input values, both numerical and alphanumeric, should be right-justified in their fields.

TITLE RECORDS

<u>T1, T2, T3 Records:</u> (Required Records)

These records provide up to three lines of information at the top of each page of output

Field	Variable	Value	Description
0	CODE	T1, T2 or T3	Record identification (3 records)
1-10	A TITLE	AN	Title information (center of title falls in record column 41).

JOB RECORDS

<u>J1 Record: First Job Record</u> (Required Record)

This record describes the type of analysis to be performed and provides specifications about the data bank.

Field	Variable	Value	Description
0	CODE	J1	Record identification
1	IAML	0	Curve number and SCS lag will be computed for each subbasin.
		1	Percent imperviousness and Snyder's lag will be computed for each subbasin. EQ record will be required.
2	ILUPRT	1	Normal print with input data displayed at start of output.
		0	Normal Print.
		-1	Suppress printout of subbasin summaries and print only watershed summary.
		-2	Same as -1 with input data displayed at start of output.
3	IFMT	0	The grid cell data bank is unformatted.
		1	The grid cell data bank is formatted. A format record (FT) is required.
4	NROW	+	The maximum row number in the data bank.
5	NCOL	+	The maximum column number in the data bank.

Exhibit 5

Field	Variable	Value	Description
6	SIZE	+	A positive number indicates the value is the size of a grid cell in acres.
		-	A negative number indicates the value is the total area in square miles of the watershed under analysis. The total will be apportioned among the subbasins.

J2 Record: Second Job Record (Required Record)

This record gives the location of the data variables in the data bank and the number of subbasins, land use categories and SCS soil categories, if SCS slope categories are used.

Field	Variable	Value	Description
0	CODE	J2	Record identification
1	NVAR	+	The number of data variables in the data bank
2	NSUB	+	The number of subbasins to be analyzed
3	IBS	+	The sequence number of the data bank variable which is the subbasin code.
4	NLUSE	+	The number of categories in the land use variable under analysis.
5	ILD	+	The data bank sequence number of the land use variable (existing, future, etc.) under analysis.
6	NSLP	0	Either actual slope or no slope values are used.
		+	The number of categories in the surface slope variable.
7	ISLP	-	The sequence number of the data bank variable which is the calculated slope.
		0	No slope data variable. Must be zero. Do not leave blank.
		+	The sequence number of the data bank variable which is the SCS land surface slope code. A positive value indicates that only average slope values from the SL record will be input.
8	IHYO	+	The sequence number of the hydrologic soil group data variable in the data bank.

Exhibit 5

ZW Record: DSS Pathname Data Record (Optional record, required for DSS file creation)

The ZW record specifies that a file will be created for use by the HEC data storage system (DSS). The DSS file will contain hydrologic loss rate and unit hydrograph parameters which can be retrieved using HEC-1. The record contains the project (part A of the pathname), alternative (part F of pathname) and optional data year (part E of pathname) that are used in the creation of the HECDSS pathname. The ZW record follows the J2 record.

Field	Variable	Value	Description
0	CODE	ZW	Record identification
1-2	PROJ	(AN)	Project or study name for HECDSS pathname.
3-5	ALT	(AN)	Plan or alternative for HECDSS pathname.
6(45-48)	IYR	+	Data year (optional).

The following parameters are written to the HECDSS file.

ISTN - HEC-1 Station number

SQMILE - Subbasin area in square miles

BASCN - SCS Subbasin curve number

BLAS - Subbasin lag for SCS method

TOTIMP - Percent imperviousness of the subbasin

TP - Time to peak for Snyder procedure

CP - Peaking coefficient for Snyder's lag procedure

Exhibit 5

FT
EQ

FT Record: Format Record (Optional Record)

The FT record is required only when the data bank is formatted, IFMT (J1.3) = 1.

Field	Variable	Value	Description
0	CODE	FT	Record identification
1-10	FMT	(AN)	The format description must have a left parenthesis in record column 3. The description of the format must be in a fixed point format. The end of the format must be followed with a right parenthesis.

SUBBASIN DATA RECORDS

EQ Record: Equation Constants Record (Optional Record)

The EQ record is required to describe the regression equation coefficients for computing Snyder's lag. Used only when IAML (J1.1) = 1. The values should be input in decimal form.

Field	Variable	Value	Description
0	CODE	EQ	Record identification
1	CONST	+	The C value in the regression equation, equation 3.
2	CONA	+	The C1 value in the regression equation, equation 3.
3	CONB	+	The C2 value in the regression equation, equation 3.

Exhibit 5

SL Records: Slope Records (Optional Records)

The SL records are required when ISLP (J2.7) is positive. The first ten slope values must appear on the first SL record. If there are more than 10 slope values, the eleventh (11) through twentieth (20) values are placed on the second SL record, until all slope classes are given a slope value.

Field	Variable	Value	Description
0	CODE	SL	Record identification
1-10	PERC	+	Average slopes (in percent) of the slope categories. There must be NSLP (J2.6) number of values in sequential order.

LU Records: Land Use Records (Required Records)

The LU record is used to associate curve number to the hydrologic soil group-land use complex. It is also used to assign percent imperviousness to a land use if the Snyder technique is used. There must be NLUSE (J2.4) number of LU records, one for each land use category.

Field	Variable	Value	Description
0	CODE	LU	Record identification
1	LANDID	+	Identification number for the land use category described on this record within land use data variable, ILD (J2.5).

The following four fields require curve numbers by hydrologic soil group for the particular land use category. May be left blank if IANL (J1.1) is 1.

2	CVNM(I,1)	+	Curve number for hydrologic soil group A.
3	CVNM(I,2)	+	Curve number for hydrologic soil group B.
4	CVNM(I,3)	+	Curve number for hydrologic soil group C.
5	CVNM(I,4)	+	Curve number for hydrologic soil group D.

Exhibit 5

Field	Variable	Value	Description
6	PERIMP	+	The percent imperviousness (0 to 100) of this land use. Sixty percent imperviousness is input as 60. Required only if J1.1 is 1.
7	TITLE	(AN)	Land use category title.

<u>SB Records: Subbasin Records</u> (Required Record)

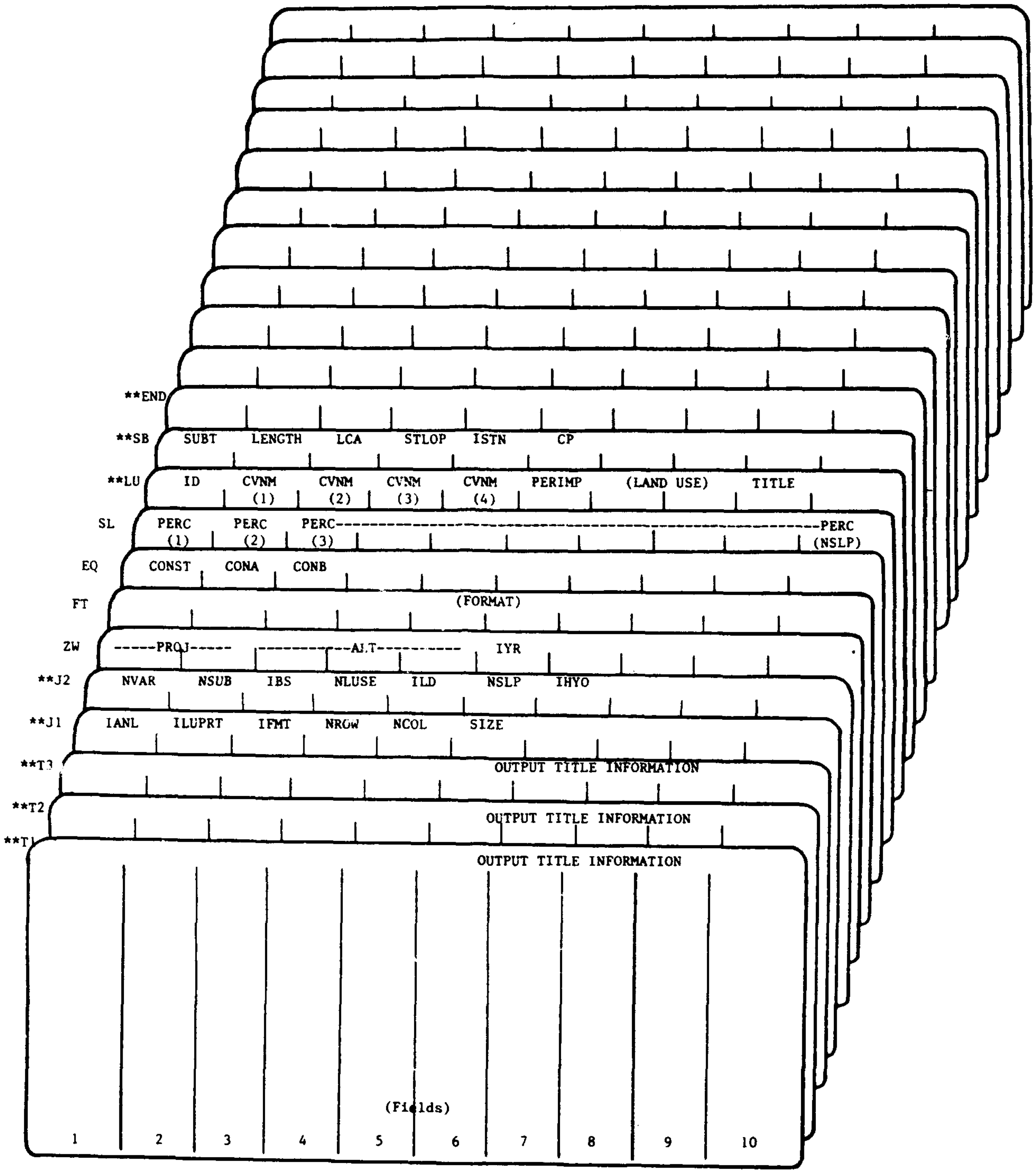
The SB record assigns physical parameters for each subbasin which cannot be captured directly from the data bank. An SB record is required for each subbasin analyzed, NSUB (J2.2).

Field	Variable	Value	Description
0	CODE	SB	Record identification
1	SUBT	+	Subbasin identification number
2	LENGTH	+	Hydraulic stream length in miles (subbasin outlet to watershed boundary) of the subbasin. It is used in Snyder's lag computations in miles and for the Curve Number calculation it is converted to feet. (Length is always output in miles for both types of calculations).
3	LCA	+	The LCA (length to centroid of the area) of the subbasin in miles. May be left blank if the SCS curve number technique issued (IANL (J1.1) = 0).
4	STLOP	+	The stream slope in feet/mile. Required for Snyder's lag computation, IANL (J1.1) = 1. As with LCA (SB.3), the STLOP value may be left blank if IANL (J1.1) = 0.
5	ISTN	AN	Subbasin identification code. (Maximum of 6 alphanumeric characters, right justified).
6	CP	+	Peaking coefficient for use with the Snyder's lag procedure.

<u>END Record: Ending Record</u> (Required record)

Field	Variable	Value	Description
0	CODE	END	Signals end of input data. Should follow last input record.

Exhibit 5



** Required record

HYDPAR RECORD STREAM

EXHIBIT 5

GPO 585-067/40025